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## Beyond answers: dimensions of the advice network

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### Abstract

In this paper, we report the result of a research project investigating social aspects of knowledge sharing and development. Prior research in a consulting firm revealed that respondents recognized five kinds of informational benefits when consulting others: solutions, meta-knowledge, problem reformulation, validation and legitimation. We employed these dimensions in a systematic network analysis of a different sample of people (human resource managers in a large conglomerate), using each of the five benefits as kinds of social relations. Two general research questions guided the analysis. First, how are these relations related to each other (multiplexity)? Do individuals obtain all of the benefits from the same individuals, or do they create balanced portfolios of complementary contacts that provide different benefits? Second, what properties and shapes do the networks induced by these relations form (structure)? What is the basis for who is tied to whom on each relation? The fundamental result emerging from both research questions is that the five relations seem to form a unidimensional scale such that a contact who provides any given benefit is also very likely to provide all the benefits that are lower on the scale. Position on this scale seems to index underlying dimensions of social solidarity rather than individual attributes such as status. Consequently, relations at the end of the scale (e.g. legitimation) were more homophilous and proved to be strongly diagnostic of subgroup boundaries, a fact which could be quite useful in consulting or other applied contexts. This research contributes to the literature on knowledge management by revealing diverse ways that consulting others facilitates knowledge creation and utilization. The research also contributes to social network analysis by examining meanings and relationships among social relations, an area that is understudied. We found that the five benefits, treated as social relations, formed an entailment structure consistent with a Guttman scale. We also found that relations lower in the scale flowed smoothly across historical organizational boundaries whereas relations higher in the scale did not. © 2001 Elsevier Science B.V. All rights reserved.

*Keywords:* Problem reformulation; Guttman scale; Advice network

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## **1. Beyond answers: dimensions of the advice network**

Knowledge management is an increasingly popular collection of organizational interventions intended to improve both the efficiency and effectiveness of work in knowledge intensive settings. To date, the bulk of these initiatives has focused on implementation of distributed databases and organizational processes to ensure capture and sharing of lessons and re-usable work products (Stewart, 1997; Davenport and Prusak, 1998; Davenport et al., 1998; O'Dell and Grayson, 1998; Ruggles, 1998). Such efforts provide a kind of organizational memory that improves efficiency by retaining useful knowledge and helps avoid repetition of past errors. However, technical solutions are only one part of the equation. Organizations are transactive knowledge systems in which the bulk of knowledge is in individuals' heads, and specialization (among other factors) ensures that each individual maintains different bundles of knowledge (Wegner, 1987). To utilize this knowledge in the solution of problems and the creation of new knowledge, organizational members must know who knows what, and interact with each other in order to utilize and combine knowledge. Thus, knowledge utilization is fundamentally a social process (Wenger, 1998). In addition, its use in achieving some organizational goal is also social because meaning which affords action is often a product of social interaction (Bartunek, 1984; Barley, 1986; Brown and Duguid, 1991; Kogut, 1996; Nonaka and Takeuchi, 1995; Szulanski, 1996; Wenger, 1998).

Given the centrality of social interaction as a vehicle for both knowledge creation and use, it is surprising that we know so little about how seeking information from other people at work results in actionable knowledge. On the one hand, research in the social network tradition has long demonstrated the importance of personal connections in the construction and acquisition of information (Granovetter, 1973; Burt, 1992; Rogers, 1995; Shah, 1998; Hansen, 1999; Hansen et al., 1999). Yet, on the other hand, there has been little investigation into what really flows when organizational members go to each other for work-related advice, although it is often assumed that more than simple answers passes between the parties (Allen, 1977; Rogers, 1995; Weick, 1995; Szulanski, 1996; Hansen, 1999). The present study was designed to help fill this gap.

Our study consisted of a network analysis of the 16 top managers in a Human Resource department of a large healthcare organization. This group had recently undertaken a significant acquisition, and so provided an opportunity to assess dimensions of advice at a network level as well as see if the components of advice acted differently within and across these newly merged groups.

## **2. The qualitative study**

To determine what people get from other people when they turn to them for information or advice, Cross (2000) conducted in-depth interviews with forty managers in a global consulting organization. He asked the respondents to reflect on a recent project (last 6 months) that they felt held significance for their career. He then asked them to identify three key people they turned to for information or advice during the course of this project and then recount in detail specifically how these people helped from an informational perspective.

What Cross (2000) found was that, in this context, people helped other people in five unique ways. Specifically, people tended to provide: (1) *solutions*; (2) *meta-knowledge*; (3) *problem reformulation*; (4) *validation* and (5) *legitimation*. Explanations of the concepts behind these summary terms are given in Table 1, and we will briefly describe each of them in the following section. The percentages found in the table are calculated on a base of 120 (40 managers times 3 contacts each). A bar chart giving the number of managers (maximum of 40) mentioning each kind of aid is given in Fig. 1.

Table 1  
Benefits obtained from asking others for information (Cross, 2000)

<p><i>Solutions</i> (57%): People get information from other people that they use to generate solutions to problems. The most valued information that is received is explicit procedural knowledge. Obtaining answers to problems allows a solution to be orchestrated in an effective and timely manner</p>	<p>“At [Company X] we have access to background information and you know lots of case studies and approaches that were really well written up. We had no experience in the practice though of actually applying it on an engagement. So what was specifically useful to me was to talk with Terry who knew what we were trying to achieve at [Company X] . . . to help me work some of this accessible content into a workable approach. What I needed to know was: How might we apply this given that we have not done it before.”</p>
<p><i>Meta-knowledge</i> (45%): An interaction that yields pointers to individuals with expertise, or the location of relevant documents. Sources in these interactions often serve a brokering function connecting a third party and the recipient. Meta-knowledge leads individuals to obtain useful information in a timely manner which increases their efficiency in responding to problems</p>	<p>“It was critical that Naomi was also able to bring to bear some work she had done in other projects. You know, she was able to say we could tap into this person who did something just like this over here or I can steal the code he wrote for this client and use it here. She had a lot of ideas of how to pull in her existing network to much more quickly get out stuff up and running.”</p>
<p><i>Problem reformulation</i> (45%): A skillful source may be able to help the recipient define important dimensions of problem. Problem reformulation enables an individual to broaden his or her understanding of problem, which in turn enables them to give a more accurate solution</p>	<p>“I often miss the dynamics in a situation that will affect people. I don’t know why, but it has bitten me before and so is something I am increasingly cognizant of . . . [that’s why] I continue to go back to her for advice . . .”</p>
<p><i>Validation</i> (49%): An interaction may be valuable in that it validates an individual’s solution or plan. It may also bolster the individual’s belief in his/her own thinking. Affirmation of an idea allows an individual to enter diverse social situation with confidence. This ensures that good solutions are not lost</p>	<p>“. . . the other times I tended to turn to him for help was when I had a problem that I had a solution for and I just wanted him to validate it. You just want someone important to say yeah, you are thinking along the right lines.”</p>
<p><i>Legitimation</i> (36%): The ability to cite a respected source as having reviewed a solution can increase credibility, and allow people to move forward in exploring an approach. The use of symbolism decreases the amount of discussion time around a decision point and therefore increases efficiency</p>	<p>“in conversations with the two heads of the E-Commerce initiative the fact that I had covered my plan with [the CIO] and [the CIO] bought into it they were like “Oh Great. We have the buy-in of IT, we don’t need to worry about that and you know, [the CIO] understands the web so we are sure that there are some good ideas there.”</p>

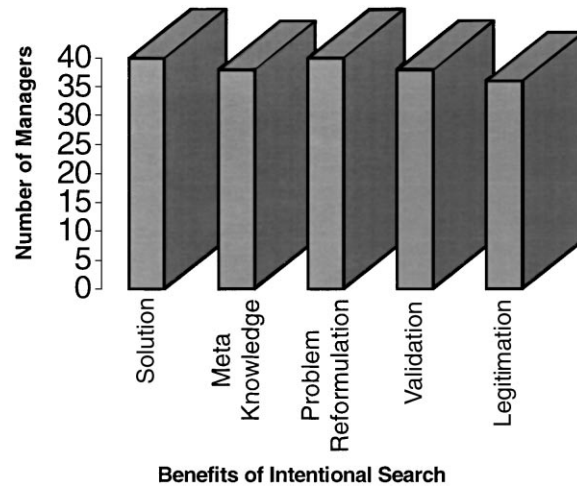


Fig. 1. Relationships valued for benefit received in intentional search.

### 2.1. Solutions

Sometimes when we turn to other people for a solution we get lucky in that they both know what we need to know and are willing to share it with us in a fashion that is helpful. Not surprisingly, in our interviews we found that specific solutions were shared in the majority (57%) of interactions studied. What was more surprising was the extent to which people distinguished between knowledge of facts (what has been called declarative knowledge or know-what) versus knowledge of how to do things (what has been called procedural knowledge or know-how). Out of the 68 interactions in which solutions were shared, only 9 were valued for know-what and 59 were valued for know-how. By and large, our respondents discounted the importance of declarative knowledge, which is what most companies are focusing their knowledge management efforts on, indicating in their stories that they relied far more heavily on other people for procedural knowledge.

### 2.2. Meta-knowledge

Very often our respondents would describe situations where they turned to people and did not get a specific solution, but learned of the location of important information (if in a database) or expertise (if in a person). In our interviews, 54 (45%) of the relationships were considered important to the success of the project because they provided information about where to find the answers they needed. These results are not surprising in the light of the extensive social networks literature on bridging and brokerage functions (Simmel, 1950; Granovetter, 1973; Freeman, 1979; Gould and Fernandez, 1989; Burt, 1992). What was notable in our interviews was the extent to which people were pointed to other people rather than to libraries and computer resources. Of the 54 relationships valued for meta-knowledge, 16 were to inanimate repositories (e.g. file cabinets and databases) and 38 were to other people.

### 2.3. *Problem reformulation*

Respondents often indicated that they valued other people for the way they could help the respondent to think differently about a specific problem. Specifically, 45% of the relationships explored were valued because they helped to reformulate problems. This tended to occur along two fronts. First, there was the kind of problem reformulation in which the contact prompted the respondent to think more broadly about a problem or to attend to dimensions that the respondent had not considered yet. Second, there was the kind in which the contact was able to predict the consequences of actions the respondent was planning, enabling the respondent to make alternative choices. Contacts who provided problem reformulation were considered valuable because they helped the managers we interviewed ensure that they were solving the right problem.

### 2.4. *Validation*

Sometimes our respondents would describe scenarios in which they turned to other people for information and did not receive any information at all, but by virtue of the other person validating their plan were more confident and thus more effective in further developing and presenting their solutions to others. In our interviews, 49% of the contacts were considered valuable at some point in the project simply because they helped validate an individual's solution or plan.

According to respondents, affirmation was important at critical junctures in projects when they were feeling uncertain as to the validity of their course of action. In many cases, these interactions were important solely because they bolstered the respondent's belief in her/his own thinking and allowed her/him to more confidently introduce and move their ideas forward in other social contexts. From a performance perspective, validation was important because it helped people be more efficient (since they did not waste time pursuing other avenues) and more effective (since they presented their ideas into diverse social contexts). Ultimately, in diverse social contexts characterized by ambiguous problems, more than just a viable solution is required for a person's knowledge to be actionable.

### 2.5. *Legitimation*

The ability to cite a respected source as having reviewed a solution can serve to increase the credibility of a proposed solution, particularly in ambiguous situations where quality is difficult to discern. In our interviews, we found that 36% of the respondents' contacts were helpful in this way. In essence, having vetted a course of action with a respected other acts as a quality tag that becomes associated with the proposed solution. As with validation, having this tag enables the actor, as well as his or her contacts, to fully engage with the proposed approach and develop it further.

## 3. **Network analysis**

The qualitative interviews offered evidence that at least five kinds of benefits can accrue to a person when seeking information through their network of contacts. The conveyance of

Table 2  
Correlation matrix<sup>a</sup>

	Solution	Meta-knowledge	Problem reformulation	Validation	Legitimation
Answer	1.00				
Meta-knowledge	0.76	1.00			
Problem reformulation	0.61	0.78	1.00		
Affirmation	0.52	0.69	0.86	1.00	
Symbol	0.48	0.56	0.64	0.76	1.00

<sup>a</sup>  $N = 240$ . All correlations significant at 0.01 level using QAP permutation test.

each of these kinds of benefits can be seen as a social relation in its own right. Our next step was to systematically measure each of these relations in a new research setting. We surveyed 16 of the top executives within the Human Resources (HR) department of a Fortune 500 company that had recently undergone a significant merger. Each of the executives was asked five questions, corresponding to the five relations. The exact questions are found in Appendix A. All questions used a 0–4 response scale in which ‘0’ indicated that the respondent did not go to a particular person in the last month and ‘4’ indicated that they turned to a given other more than seven times within the last month. The resulting data matrices are found in Appendix B. The survey also included demographic questions regarding tenure in the organization, title and which division of the organization each of the respondents belonged to.

One of the goals of this phase of the research was to learn whether respondents used different contacts to obtain the five kinds of information benefits, or whether they obtained multiple benefits from the same individuals. As a first step in answering this question, Table 2 shows the correlations among the five relations.<sup>1</sup> The results indicate that some pairs of relations are quite well correlated, while others are not. A metric multi-dimensional scaling (stress 2 < 0.01) of the correlation matrix (Fig. 2) shows that the relations line-up along a single, curvilinear dimension in the following order: solution, meta-knowledge, problem reformulation, validation and legitimation. Although it is tempting to interpret the plot in two-dimensions, it should be noted that the horseshoe shape is a well-known phenomenon which Kruskal and Wish (1978: Appendix B) view as one-dimensional, and in any case a one-dimensional solution fits reasonably well (stress 2 < 0.13; see Fig. 3).

The reason for this particular ordering (1 of 120 possible) is an open question. One possible answer is that it reflects semantic distance from the prototypical kind of response that we ordinarily expect when we ask others for information. Simple solutions are the most obvious and unsurprising response, and can be thought of as a single-loop response — i.e. a response to an external stimulus that does not change the underlying assumptions of the situation (Bateson, 1972; Argyris and Schon, 1974). Meta-knowledge, while fairly concrete, is a step removed from a simple answer. Problem reformulation is also a step removed, and can be thought of as a double-loop response — i.e. a response that questions and changes the premise of the question (Argyris and Schon, 1974). Unlike the previous three types of aid, validation is not an answer at all, and is therefore further removed. Finally, legitimation is also not an answer, serving primarily a political function.

<sup>1</sup> Correlations obtained via the QAP correlation procedure in UCINET 5 for Windows (Borgatti et al., 1999).

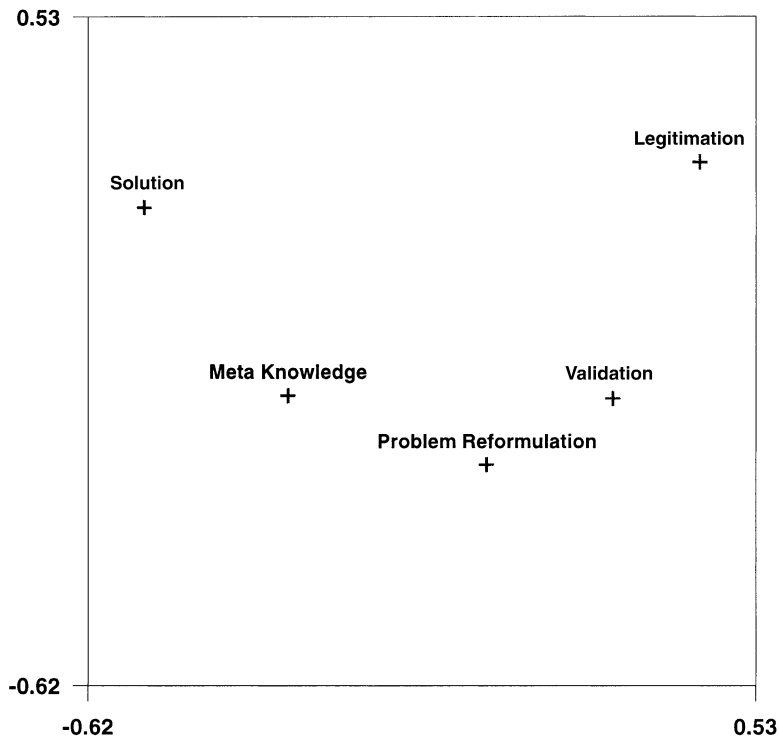


Fig. 2. Metric MDS of correlation matrix. Stress < 0.01.

The unidimensional scale emerging from the MDS, together with the fact that the average tie strength across matrices declines along the same dimension (see Table 3), suggests the possibility that the relations might possess an entailment structure, in the manner of a Guttman scale (Friedkin, 1990). We tested that by dichotomizing the data at each possible level, and for each value, running a Guttman scaling procedure. To do this, we rearranged the values of each matrix into a column vector with  $n(n-1)$  cells (the diagonal was omitted), creating a new data matrix with 240 rows and five columns. This was input to the Guttman scaling program in Anthropac (Borgatti, 1985). As shown by coefficients of reproducibility and scalability in Table 4, the relations in fact satisfy the conditions of a Guttman scale at all levels of dichotomization. Furthermore, it turns out that the ranking of relations in the Guttman scales are, in all cases, identical to the MDS ordering. Thus, if manager A seeks legitimation aid from manager B, then with very few exceptions, he or she also seeks all the other information benefits from B as well. Similarly, if A seeks validation from B, then he or she also seeks solutions, meta-knowledge, and problem reformulation from B.

The fact that these relations form a Guttman scale suggests that managers do use different people for different things, but that this is based on a kind of ranking (a different one for each respondent) in which some contacts are used for everything, while others are used for 'intermediate' things, and still others are only used for 'simple' things. Based on comments

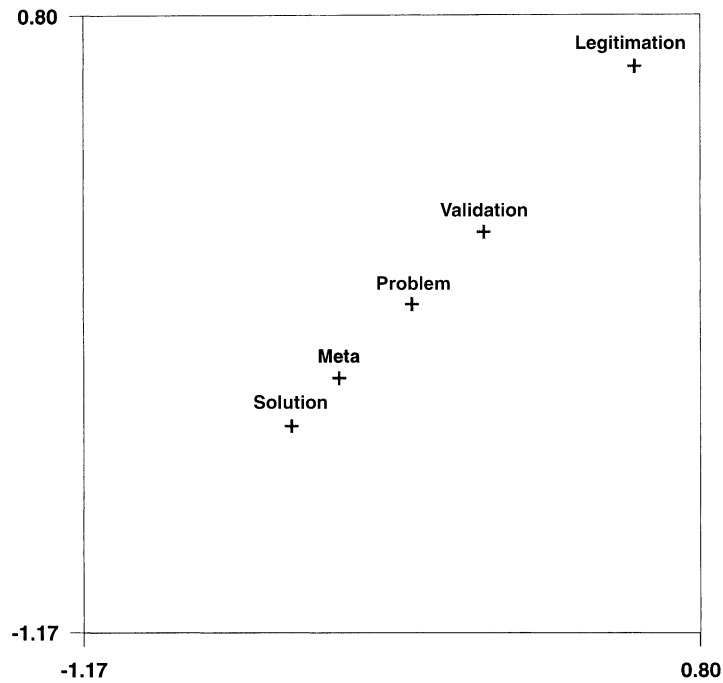


Fig. 3. One-dimensional metric MDS.

Table 3  
Average tie strength

	Average
Solution	0.96
Meta-knowledge	0.76
Problem reformulation	0.50
Validation	0.40
Legitimation	0.29

made by a few respondents in the qualitative phase of this study, we had anticipated that managers would construct their personal networks so as to be able to draw upon a portfolio of skills across many different individuals with complementary skills. This does not appear to be the case, at least not in the way originally conceived. As shown in Table 5, only 10 (63%) of the managers obtain all five benefits from any combination of contacts.<sup>2</sup> (For example, actor CC receives only three of the possible five benefits from his network, obtaining solutions from five contacts, meta-knowledge from two contacts, and problem

<sup>2</sup> However, the network data were limited to ties among members of one department of a larger organization. We did not collect data on any ties the respondents may have had with people outside the department. This was not true of the qualitative study.



Table 4  
Guttman scaling fit statistics

Dichotomization		
Level	Cr <sup>a</sup>	CS <sup>b</sup>
≥1	0.975	0.902
≥2	0.994	0.955
≥3	0.998	0.981
≥4	0.994	0.907

<sup>a</sup> CR: coefficient of reproducibility.

<sup>b</sup> CS: coefficient of scalability.

reformulation from one contact; these figures are row sums of the dichotomized adjacency matrices.) Furthermore, rather than developing a portfolio of contacts with complementary skills, the Guttman entailment structure of the benefits dictates that if two contacts each provide two benefits, then these will likely be the same two benefits (in fact, they will be answers and meta-knowledge).

To establish that this entailment structure holds true at the individual level, we ran Guttman scaling procedures on each individual separately (dichotomizing the data at 1 and above), and then counted the number of contacts (0–15) providing each number of benefits (0–5). Table 6 gives the counts for each individual. For example, actor TB has one contact who provided all five benefits, one contact who provided the first four (solution, meta-knowledge, problem reformulation and validation), and six contacts who provided the first two (solution and meta-knowledge). In addition, there were six members of the group that TB did not turn to at all (received no information benefits from). Column totals for each row are also

Table 5  
No. of contacts delivering each benefit (row sums)

	Solution	Meta-knowledge	Problem reformulation	Validation	Legitimation
JB	12	12	7	5	4
TB	9	9	2	2	2
MC	5	6	4	4	1
CC	5	2	1	0	0
BD	8	7	6	5	0
TD	12	11	8	7	7
PD	4	4	1	1	1
JF	7	5	4	4	4
KG	9	8	4	3	0
SM	6	3	2	2	2
BS	6	3	3	2	2
AS	6	5	1	1	0
JT	2	2	0	0	0
PW	10	8	4	6	4
CW	7	7	3	1	4
TW	2	0	0	0	0
Total	110	92	50	43	31

Table 6  
Frequencies of relational bundles

	0	1	2	3	4	5	Total
JB	2	1	2	3	2	2	12
TB	6	0	6	0	1	1	14
MC	9	1	1	0	3	1	15
CC	9	4	0	1	0	0	14
BD	7	1	1	1	5	0	15
TD	3	1	2	1	1	6	14
PD	11	0	2	0	1	0	14
JF	8	2	1	0	0	4	15
KG	0	1	4	1	3	0	9
SM	9	3	0	0	1	1	14
BS	9	3	0	0	1	1	14
AS	9	1	3	1	0	0	14
JT	13	2	0	0	0	0	15
PW	4	3	2	1	0	4	14
CW	8	2	0	2	1	1	14
TW	13	2	0	0	0	0	15
Total	120	27	24	11	19	21	222

given in the table. These would all be 15 (i.e.  $n - 1$ ) except that we have ignored those contacts that have Guttman scale errors.<sup>3</sup> Note that the Guttman model fit each individual quite well, so that most respondents had only one scale error.<sup>4</sup> The column marginals of the table indicate that respondents have a slight tendency to either seek many benefits from the same contact or just a few, but not a moderate number (such as 3).

It is interesting to note that the contacts who provided, say, all five benefits to a given respondent were not necessarily the same contacts to do it for another respondent. For example, Fig. 4 shows the adjacency matrix resulting from multiplying, element-wise, all five dichotomized relations to obtain the intersection of them all, such that in the new matrix there is a tie from  $i$  to  $j$  if and only if there is a tie from  $i$  to  $j$  on all five relations. cursory inspection of the matrix shows that most individuals (columns) provide the complete bundle of services to just one person, and that the maximum indegree is only 3 (for BD). This means that the reason for the Guttman entailment structure among the relations is not that there are some individuals that are simply more talented than others and widely recognized as such. Instead, each respondent seems to have a different view of who can provide what. This suggests that the basis for the entailment of relations is not an individual characteristic, such as formal status, but a relational variable such as trust or closeness or friendship. This issue is addressed in more detail at the end of the paper.

A second goal of the network analysis was to understand the different structural patterns of connection induced by each relation. To do this, we began by dichotomizing each valued adjacency matrix at 1 or above, and drawing the networks using the annealing option in

<sup>3</sup> Contacts with Guttman scale error are those from whom the respondent obtained “impossible” combinations of benefits, such as receiving solutions and legitimation but no others.

<sup>4</sup> In addition, the ordering of relations was identical to the aggregate ordering in all cases.

	JB	TB	MC	CC	BD	TD	PD	JF	KG	SM	BS	AS	JT	PW	CW	TW
JB	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
TB	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
MC	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
CC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TD	0	1	0	0	0	0	1	0	1	0	1	0	1	0	1	0
PD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
JF	0	0	1	0	1	0	0	0	0	1	0	0	0	1	0	0
KG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SM	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
BS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
AS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
JT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PW	0	0	1	0	1	0	0	1	0	1	0	0	0	0	0	0
CW	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
TW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Fig. 4. Adjacency matrix for the intersection of all five relations.

Krackplot (Krackhardt et al., 1994). In each diagram (see Fig. 5a–e), an arrow from one person to another indicates that the first person says they seek an informational benefit from the second. We classified each executive into one of three groups based on whether he or she was part of the original organization (square nodes), the recent large acquisition (circle nodes), or other more distant acquisitions (plain nodes).

Visual inspection of the five diagrams (arranged according to the ordering uncovered earlier) immediately reveals two trends. First, density decreases in the expected manner (given our previous results) as we move from solutions to legitimation, indicating that relatively fewer contacts provide the benefits at the end of the scale.

Second, the graphs at the end of the series seem to show more segregation by group. In the solutions network, there are quite a few ties between groups, although some evidence of homophily appears to be present. In the meta-knowledge network, the members of the new acquisition stand out as a group of their own. In the problem reformulation network, the members of the original firm coalesce into a visible group. In the validation network, the new acquisition and the original firm have just one direct tie to each other. Interestingly, two members of the older acquisitions (plain nodes) occupy structural positions that would enable them to serve as liaisons between the new acquisition and the original firm, while the other three members of the older acquisitions are emphatically peripheral. Finally, in the legitimation network, the original firm and the new acquisition are wholly disconnected from each other, and the members of the older acquisitions form part of the original firm cluster.

We can evaluate the extent of homophily and segregation more precisely by fitting a variable homophily categorical autocorrelation model (Borgatti et al., 1999). The test is essentially an analysis of variance — carried out via dummy-variable QAP regression (Krackhardt, 1990) — in which there is a parameter estimated for each group of managers, interpretable as a measure of tendency toward ‘inbreeding’ or homophily. The word “variable” in the name of the model indicates that separate inbreeding parameters are

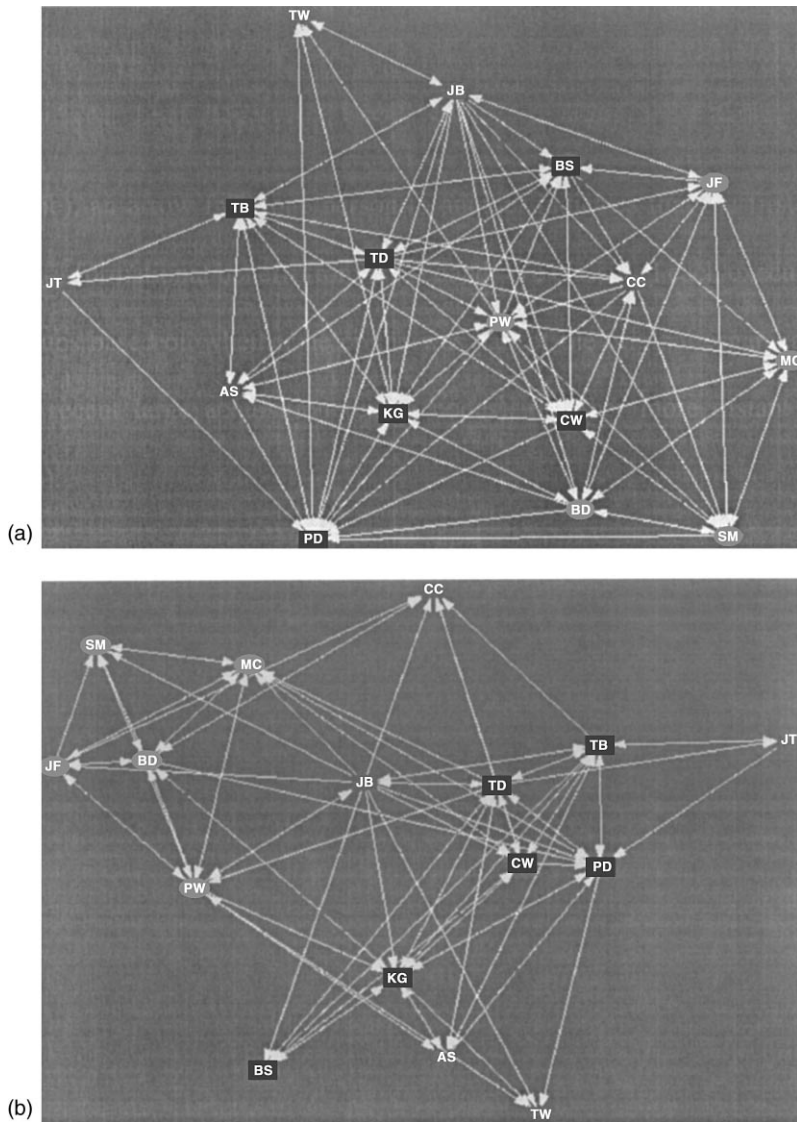


Fig. 5. (a) Solutions. An arrow from *i* to *j* indicates that *i* seeks answers from *j*. Squares identify members of original firm, circles identify a recent large acquisition, and plain nodes identify members of older smaller acquisitions; (b) meta-knowledge; (c) problem reformulation; (d) validation; (e) legitimation.

estimated for each group, rather than a single parameter common to all groups. Hence, the variable model allows each group to have a different tendency toward homophily, whereas the constant homophily model assumes all groups have the same tendency. The model's fit is indicated by the  $r^2$  coefficient, and a high  $r^2$  indicates that there are more ties within group than between group.

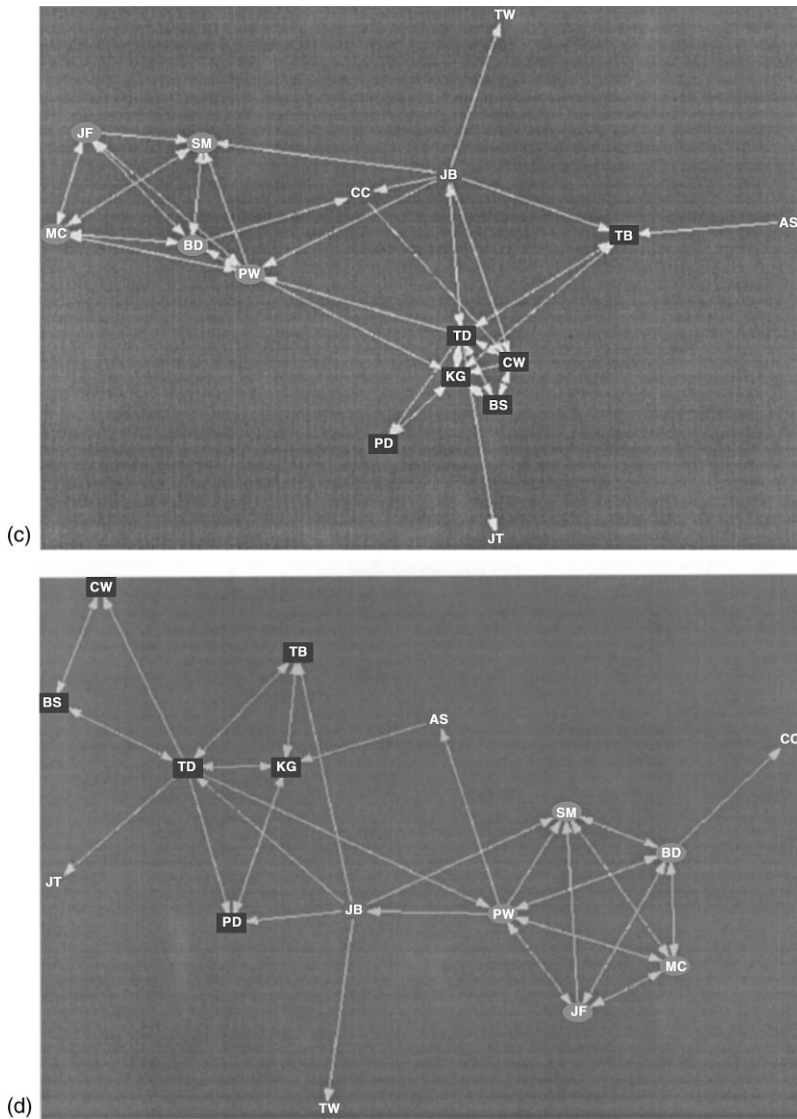


Fig. 5. (Continued).

Table 7 gives the unstandardized regression coefficients estimated for each network, along with the  $r^2$ . As shown in the table, the  $r^2$  values increase fairly consistently as we move from solution to legitimation, indicating increased segregation. In addition, the regression coefficients show that the members of the new acquisition are the most homophilous, and this difference becomes more pronounced in the more abstract relations. The members of the old acquisitions are the least homophilous. This makes sense because they are drawn from different companies. Visual inspection of the network diagrams shows that the bulk

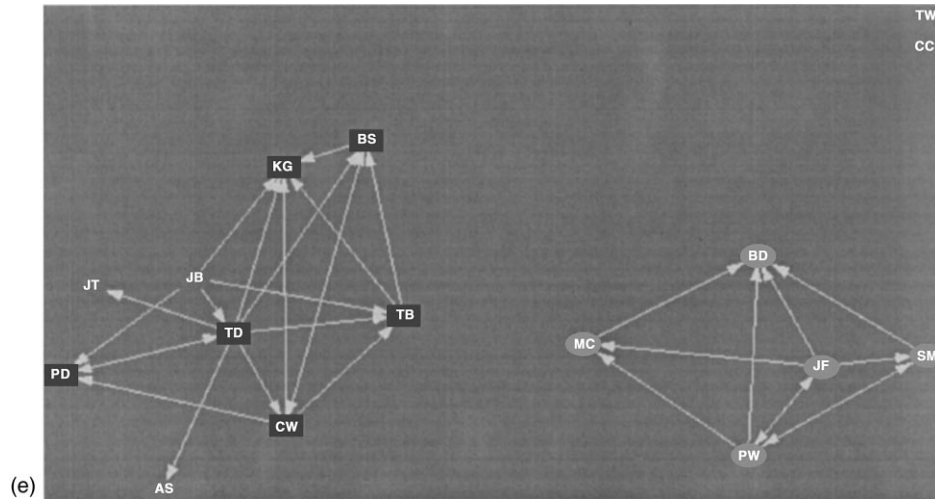


Fig. 5. (Continued).

Table 7  
Autocorrelation results (three groups)

	Solution	Meta-knowledge	Problem reformulation	Validation	Legitimation
Original firm	0.39**	0.55**	0.54**	0.42**	0.7**
Old acquisitions	-0.34*	-0.19	0.07	-0.02	-0.1
New acquisition	0.46**	0.61**	0.87**	0.88**	0.8**
$r^2$	0.179**	0.242**	0.394**	0.388**	0.54**

of their ties are with members of the original firm, indicating a certain level of integration. This suggests that we might consider combining the older acquisitions with the original firm to form a single group. Table 8 gives the results of the variable homophily model based on just two groups. The results are similar to those based on three groups.

Why does homophily increase as we move from solution to legitimation? Earlier, we interpreted this dimension in terms of abstractness or semantic distance from a prototypical image of what you could expect to receive when you interact with others to solve problems. However, it is not obvious how such a dimension should be associated with increasing homophily. We make the following intuitive suggestion: the more removed from

Table 8  
Autocorrelation results (two groups)

	Solution	Meta-knowledge	Problem reformulation	Validation	Legitimation
Original + old acquisitions	0.22**	0.35**	0.24**	0.16**	0.5**
New acquisition	0.55**	0.73**	0.91**	0.91**	0.9**
$r^2$	0.11**	0.203**	0.304**	0.319**	0.479**

Table 9  
Reciprocity rates<sup>a</sup>

	Dichotomization level			
	≥1	≥2	≥3	≥4
Solution	72	84	86	88
Meta-knowledge	78	83	88	90
Problem reformulation	87	86	90	92
Validation	88	87	91	93
Legitimation	81	86	90	93

<sup>a</sup> Table values are percentages of dyads.

a simple solution something is, the more trust, experience and/or closeness is needed to utilize the benefit: trust because it is difficult to evaluate someone's reformulation of a problem; experience because understanding more complex or abstract help requires more shared tacit knowledge, which is obtained over time through repeated interactions;<sup>5</sup> and closeness because the relations at the end of the spectrum (i.e. validation and legitimation) are meaningful to the extent you respect the source. All of these can be expected to be greater within groups than between, partly because of shared identity, and partly because of time spent together, leading to the observed result that homophily increases as we move from solution to legitimation.

If this explanation is correct, we should see some evidence in reciprocity. Given that individuals have different spheres of expertise, our naïve expectation was that the relations at the beginning of the scale (i.e. solutions and meta-knowledge) would show high numbers of reciprocal ties, while relations at the end of the scale (i.e. validation and legitimation) would show low levels of reciprocity because these relations would be a function of individual status. This does not seem to be the case, as shown in Table 9. On the contrary, reciprocity largely increases as we move from solution to legitimation.<sup>6</sup> This is consistent with the view expressed in the previous paragraph that the end of the scale reflects greater levels of social solidarity, since solidarity can be expected to be symmetric, unlike status relations.

In general, status, whether formal or informal, does not seem to be a key factor in these data. In our sample, individuals could be classified into three ranks: directors, senior vice-presidents, and vice-presidents. We tested the tendency for people of one formal rank to differentially seek out members of specific other ranks by using a permutation-based categorical autocorrelation test similar to the variable homophily model used earlier.<sup>7</sup> In this model, a parameter is specified for every  $r \times r$  pair of classes in the categorical variable, minus one, which becomes the reference category. Thus, the tendency for any one rank to seek help from any other rank is captured. As shown in Table 10, the  $r^2$  values obtained

<sup>5</sup> In addition, Friedkin's (1990) Guttman scaling of a set of social relations found that seeking help from another entailed having frequent discussions with them.

<sup>6</sup> There is a hint of decline in reciprocity for the legitimation relation. Inspection of the diagram in Fig. 5e suggests that this is mostly due to the members of the recent acquisition, who seem to have a status system in place with BD at the top of the lattice and MC as a clear number 2.

<sup>7</sup> The model is available in UCINET 5 for Windows (Borgatti et al., 1999) as the "structural blockmodel" option within the ANOVA-based categorical autocorrelation procedure.

Table 10  
Formal status autocorrelation results

	$r^2$	Significant
Solution	0.025	0.897
Meta-knowledge	0.041	0.655
Problem reformulation	0.060	0.302
Validation	0.040	0.490
Legitimation	0.050	0.378

Table 11  
QAP correlations with status difference

	Correlation	Significant
Solution	0.028	0.365
Meta-knowledge	0.010	0.450
Problem reformulation	0.032	0.329
Validation	0.063	0.219
Legitimation	0.244	0.005

from each of the five relations are essentially zero. In addition (not shown), the relationships did not necessarily follow the expected pattern.

We also examined informal status by computing indegrees on each relation and relating these to help seeking. Specifically, if people seek help from those who have higher informal status, then we should see a high correlation between each adjacency matrix and a matrix of status differences — i.e. a new matrix  $S$  in which  $s_{ij} = d_j - d_i$ . The QAP correlations (Hubert and Baker, 1978), given in Table 11, show that none of the relations are characterized by people seeking help from those with greater informal status, with the exception of legitimation. For the legitimation relation, the correlation is modest but significant. A look at the diagram in Fig. 5e suggests that the effect is largely due to the recent acquisition (circle nodes), as discussed earlier.

#### 4. Conclusion

We have reported the results of a research project investigating social aspects of knowledge sharing and development. Prior research in a consulting firm revealed that respondents recognized five kinds of informational benefits when consulting others: solutions, meta-knowledge, problem reformulation, validation and legitimation. We employed these dimensions in a systematic network analysis of a different sample of people (human resource managers in a large conglomerate), using each of the five benefits as kinds of social relations. Two general research questions guided the analysis. First, how are these relations related to each other (multiplexity)? Do individuals obtain all of the benefits from the same individuals, or do they create balanced portfolios of complementary contacts who provide different benefits? Second, what properties and shapes do the networks induced by these relations form (structure)? What is the basis for who is tied to whom on each relation?



The fundamental result emerging from the network analysis was that the five relations seem to form a unidimensional scale such that a contact who provides any given benefit is also very likely to provide all the benefits that are lower on the scale. Position on this scale seems to index underlying dimensions of social solidarity rather than individual attributes such as status. Consequently, relations at the end of the scale (e.g. legitimation) were more homophilous and proved to be strongly diagnostic of subgroup boundaries, a fact which could be quite useful in consulting or other applied contexts.

While it is widely understood that different social relations (say, “dislikes” and “has sex with”) can yield different network structures and have different effects on the individuals involved, the meanings and interrelationships of social relations is a topic that is understudied in social network analysis (Burt and Schott, 1985). A disregard for relational contents, together with the demands of convenience, often dictates that we collect data on only the broadest of relations. For example, in knowledge management studies, we typically ask something like “who do you go to for advice on work-related matters?” But this study has shown that individuals recognize many different kinds of advice on work-related matters, and that these different kinds of advice connect different people, yield different structures, and probably hold very different meanings for people. In particular, we found that certain kinds of information benefits flow more readily across newly merged organizational boundaries than others, giving the analyst a very different picture of the pattern and level of social integration of a group.

Our findings illustrate the importance of going beyond the advice network to uncover the dimensions of advice that underpin the advice network. When companies look at knowledge sharing and learning they normally get a view only of who goes to whom for a solution. As a result, they potentially miss the even more important dimensions of meta-knowledge, problem reformulation, validation, and legitimation.

## Appendix A. Network questions

### A.1. Response scale

- 0: I have not turned to this person during the last month.
- 1: I have turned to this person 1–2 times during the last month.
- 2: I have turned to this person 3–4 times during the last month.
- 3: I have turned to this person 5–6 times during the last month.
- 4: I have turned to this person 7 or more times during the last month.

1. (Solutions) Indicate the extent to which you have turned to each of the following people within the last month for *answers to fairly specific or detailed questions* at work.
2. (Meta-knowledge) Indicate the extent to which you have turned to each of the following people within the last month for *general guidance or referrals to other sources of information*.
3. (Problem reformulation) We often turn to other people for their ability to help us *think through a problem* even when they may not have specific information that we need. Such people help us consider various dimensions of a problem and anticipate issues and

concerns likely to appear in the future. Indicate the extent to which you have turned to each of the following people within the last month for such assistance.

4. (Validation) Often we turn to other people and do not receive any information whatsoever. However, being able to talk through ideas with another person bolsters *self-confidence and thinking and makes you more willing to introduce your ideas to others and more confident in expressing them*. Indicate the extent to which you have turned to each of the following people within the last month for such a purpose.
5. (Legitimation) Sometimes we turn to someone for information and advice solely for the ability to say we have *spoken with that person about our ideas*. The individuals may be in a higher position within the organization or a perceived expert in a given area. Indicate the extent to which you have turned to each of the following individuals within the past month for such a purpose.

## Appendix B. Network data

	JB	TB	MC	CC	BD	TD	PD	JF	KG	SM	BS	AS	JT	PW	CW	TW
Seeks solutions from																
JB	0	2	0	1	1	3	2	1	2	1	1	0	0	1	1	2
TB	1	0	0	1	0	1	1	0	4	0	2	2	2	0	2	0
MC	0	0	0	0	2	0	0	3	0	2	0	0	0	2	1	0
CC	0	0	0	0	0	0	1	1	0	1	0	0	0	1	1	0
BD	0	0	4	2	0	0	1	4	2	4	0	1	0	4	0	0
TD	4	4	3	2	0	0	4	1	4	0	4	4	4	2	3	0
PD	0	1	0	0	0	2	0	0	2	0	0	0	0	0	0	1
JF	1	0	4	1	4	0	0	0	0	4	1	0	0	4	0	0
KG	0	4	0	0	1	4	4	0	0	0	4	2	0	1	2	2
SM	0	0	1	0	2	0	1	2	0	0	0	0	0	1	1	0
BS	0	1	1	1	0	2	0	0	2	0	0	0	0	0	2	0
AS	0	2	0	0	0	2	1	0	2	0	1	0	0	1	0	0
JT	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0
PW	0	0	4	0	4	0	1	4	2	4	2	2	0	0	1	3
CW	0	2	1	1	0	1	1	0	3	0	3	0	0	0	0	0
TW	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Seeks meta-knowledge from																
JB	0	1	1	1	0	2	2	1	1	1	1	0	0	1	1	1
TB	1	0	0	1	0	1	1	0	4	0	1	1	1	0	1	0
MC	0	0	0	0	2	0	1	3	0	2	0	0	0	2	1	0
CC	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0
BD	0	0	4	2	0	0	1	4	2	4	0	0	0	4	0	0
TD	3	4	3	2	0	0	4	0	4	0	4	4	4	1	3	0
PD	0	1	0	0	0	2	0	0	2	0	0	0	0	0	0	1
JF	0	0	4	1	4	0	0	0	0	4	0	0	0	4	0	0



	JB	TB	MC	CC	BD	TD	PD	JF	KG	SM	BS	AS	JT	PW	CW	TW
Seeks legitimation from																
JB	0	1	0	0	0	2	1	0	0	1	0	0	0	0	0	1
TB	0	0	0	0	0	1	0	0	4	0	0	0	0	0	0	0
MC	0	0	0	0	2	0	0	2	0	1	0	0	0	1	0	0
CC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BD	0	0	4	2	0	0	0	5	0	4	0	0	0	4	0	0
TD	0	3	0	0	0	0	3	0	4	0	0	0	2	1	3	0
PD	0	0	0	0	0	0	0	0	2	0	4	0	0	0	0	0
JF	0	0	4	0	4	0	0	0	0	4	0	0	0	4	0	0
KG	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0
SM	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0
BS	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0
AS	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
JT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PW	1	0	4	0	4	0	0	4	0	2	0	1	0	0	0	0
CW	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
TW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

## References

- Allen, T., 1977. *Managing the Flow of Technology*. MIT Press, Cambridge, MA.
- Argyris, C., Schon, D.A., 1974. *Theory in Practice: Increasing Professional Effectiveness*. Jossey-Bass, San Francisco.
- Barley, S., 1986. Technology as an occasion for restructuring. *Administrative Science Quarterly* 31 (1), 78–109.
- Bartunek, J., 1984. Changing interpretive schemes and organizational restructuring. *Administrative Science Quarterly* 29 (3), 355–373.
- Bateson, G., 1972. *Steps to An Ecology of Mind*. Ballantine, New York.
- Borgatti, S.P., 1985. *Anthropac*. Analytic Technologies, Columbia.
- Borgatti, S.P., Everett, M.G., Freeman, L.C., 1999. *Ucinet 5 for Windows*. Analytic Technologies, Natick.
- Brown, J.S., Duguid, P., 1991. Organizational learning and communities-of-practice toward a unified view of working, learning and innovation. *Organization Science* 2 (1), 40–57.
- Burt, R., 1992. *Structural Holes*. Harvard University Press, Cambridge, MA.
- Burt, R.S., Schott, T., 1985. Relation contents in multiple networks. *Social Science Research* 14, 287–308.
- Cross, R., 2000. More than an answer: how seeking information through people facilitates knowledge creation and use. Paper presented at Academy of Management Conference, Toronto, Canada.
- Davenport, T., Prusak, L., 1998. *Working Knowledge*. Harvard Business School Press, Boston, MA.
- Davenport, T., DeLong, D., Beers, M., 1998. Successful knowledge management projects. *Sloan Management Review*, 43–57.
- Freeman, L., 1979. Centrality in social networks: I. Conceptual clarification. *Social Networks* 1, 215–239.
- Friedkin, N.E., 1990. A Guttman scale for the strength of an interpersonal tie. *Social Networks* 12, 239–252.
- Gould, R., Fernandez, J., 1989. Structures of mediation: a formal approach to brokerage in transaction networks. *Sociological Methodology*, 89–126.
- Granovetter, M., 1973. The strength of weak ties. *American Journal of Sociology* 78, 1360–1380.
- Hansen, M., 1999. The search-transfer problem: the role of weak ties in sharing knowledge across organization sub-units. *Administrative Science Quarterly* 44, 82–111.

- Hansen, M., Podolny, J., Pfeffer, J., 1999. So many ties, so little time: a task contingency perspective on the value of social capital in organizations. Working Paper, Harvard Business School, Boston, MA.
- Hubert, L.J., Baker, F.B., 1978. Evaluating the conformity of sociometric measurements. *Psychometrika* 43, 31–41.
- Kogut, B., 1996. What do firms do? Coordination, identity and learning. *Organization Science* 7 (5), 502–519.
- Krackhardt, D., 1990. Predicting with social networks: nonparametric multiple regression analysis of dyadic data. *Social Networks* 10, 383–397.
- Krackhardt, D., Blythe, J., McGrath, C., 1994. Krackplot 3.0: an improved network drawing program. *Connections* 17 (2), 53–55.
- Kruskal, J., Wish, M., 1978. *Multidimensional Scaling*. Sage, Beverly Hills.
- Nonaka, I., Takeuchi, H., 1995. *The Knowledge-Creating Company*. Oxford University Press, London.
- O'Dell, C., Grayson, C.J., 1998. *If Only We Knew What We Know*. Free Press, New York, NY.
- Rogers, E., 1995. *Diffusion of Innovations*, 4th Edition. Free Press, New York, NY.
- Ruggles, R., 1998. The state of the notion: knowledge management in practice. *California Management Review* 40 (3), 80–89.
- Shah, P., 1998. Who are employee's social referents? Using a network perspective to determine referent others. *Academy of Management Journal* 41 (3), 249–268.
- Simmel, G., 1950. *The Sociology of Georg Simmel*. Free Press, New York, NY.
- Stewart, T., 1997. *Intellectual Capital: The New Wealth of Organizations*. Doubleday, New York, NY.
- Szulanski, G., 1996. Exploring internal stickiness: impediments to the transfer of best practice within the firm. *Strategic Management Journal* 17 (5), 27–43.
- Wegner, D., 1987. Transactive memory: a contemporary analysis of group mind. In: Mullen, B., Goethals, G. (Eds.), *Theories of Group Behavior*. Springer, New York, NY, pp. 185–208.
- Weick, K.E., 1995. *Sensemaking in Organizations*. Sage, Thousand Oaks, CA.
- Wenger, E., 1998. *Communities of Practice*. Oxford University Press, Oxford, UK.